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First Named Inventor	Thompson M. Sloane et al.
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ENCLOSURES ***(check all that apply)***

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- ☐ Amendment / Reply
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  - ☐ Affidavits/declaration(s)
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- ☐ Information Disclosure Statement
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Date	August 21, 2006		

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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application No.:	10/602,938
Filing Date:	June 24, 2003
Applicant:	Thompson M. Sloane, et al.
Group Art Unit:	3748
Examiner:	Zelalem Eshete
Title:	ACETYLENE-BASED ADDITION FOR HOMOGENEOUS-CHARGE COMPRESSION IGNITION (HCCI) ENGINE OPERATION
Attorney Docket:	GP-303216 (8540R-000038)

Mail Stop Appeal Brief - Patents
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REPLY BRIEF FILED UNDER 37 C.F.R. § 41.41

Sir:

This is Appellants' reply to the Examiner's Answer mailed June 20, 2006.

Reply to Examiner's Arguments

Appellants reply that the Examiner has not met the burden to establish a *prima facie* case of obviousness for the rejected claims, as is discussed in more detail below.

Prima Facie Obviousness Has Not Been Established for Claims 1-17 and 20-35

The rejected claims are not rendered obvious by the cited art and should be allowed. The cited references, either singly or combined, do not suggest or provide the necessary motivation to arrive at the invention as claimed. As such, the burden has not been met to establish a *prima facie* case of obviousness for the rejected claims.

While Applicants are mindful that obviousness cannot be established by individual dissection and attack of each reference in a combination of cited references, in the present circumstance, the claimed subject matter is not suggested based upon the teachings of the cited prior art or knowledge in the art. Obviousness can only be established by combination of references where there is some teaching, suggestion, or motivation to do so found either explicitly or implicitly in the references themselves or in the knowledge generally available to one of ordinary skill in the art. *In re Kotzab*, 55 USPQ.2d 1313,1317 (Fed. Cir. 2000); MPEP §2143.01(I). Further, the mere fact that references can be combined does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination, *i.e.,* that they should be combined. *See e.g., In re Mills*, 16 USPQ.2d 1430, 1432 (Fed. Cir. 1990); MPEP §2143.01(III).

Here, while the respective teachings of the cited references can be pieced together to arrive at the claimed invention, a deficiency still remains because nowhere

do the references provide a motivation to arrive at the invention found in Claims 1-17 and 20-35. Obviousness cannot be established by simply stating that the references all relate to the same broad category of art (engines generally) and then providing an unsupported statement that one of skill in the art would combine such teachings together. *In re Fine,* 5 USPQ.2d 1596, 1599 (Fed. Cir. 1988) *and In re Jones,* 21 USPQ.2d 1941, 1944-45 (Fed. Cir. 1992). Essentially, this is a circumstance where the Examiner may have established that the references can be combined, but has not pointed out the required motivation in that they should be combined. The references fail to provide the motivation for combination when the claims are properly considered as a whole.

Independent Claim 1 recites a limitation of initiating fuel injection and concurrently initiating injection of an acetylene-based component to form a combustion mixture. Such concurrent injection of fuel and the acetylene-based component provides robust and stable combustion over a wide range of operating conditions for a homogenous-charge compression (HCCI) engine, while producing low emissions, optimal heat release, and low noise, which are not suggested by any of the cited references. To this end, Claim 1 also recites that air, fuel and the acetylene-based component are mixed to form a combustion mixture. The combustion mixture is compressed to induce auto-ignition. Energy is released and the mixture is converted to exhaust gas. Thus, the claimed invention relates to a continuous process of combustion, where a homogeneous charge is introduced to a cylinder. Similar limitations are found in independent Claims 13 and 27, as well as in dependent Claims 2-17 and 20-35.

The cited art fails to disclose or even suggest either i) initiating concurrent injection of a fuel with an acetylene-based component to form a homogenous (pre-mixed) charge or ii) a continuous process where an acetylene-based component and a fuel are concurrently injected and mixed with air to form a combustion mixture. None of the cited references provide motivation adopt modification I) or ii), as an examination of the cited references reveals.

EP 0643209 to Dahung

The Dahung reference teaches introducing a "pilot fuel," but only during discrete periods of operation, rather than continuously operating an (HCCI) engine by forming a combustion mixture, as recited in the various rejected claims. As the primary cited reference, Dahung fails to provide the suggestion or motivation necessary to arrive at the claimed invention.

Dahung states that a main fuel, natural gas, cannot be self-ignited in a compression cylinder as disclosed. See *e.g.*, Col. 2 lines 36-40 and 52-55. Hence, a "pilot fuel serves to ignite the main fuel." Col. 2 lines 39-40. Thus, the pilot fuel is used to initiate combustion in the cylinder. The preferred pilot fuels are methanol or standard diesel fuel oil, which serve to ignite the main fuel. Col. 2 lines 13-14.

The teachings of Dahung further focus on staged sequences for introducing the pilot and main fuels to the cylinder, reinforcing the ignition role for the pilot fuel. This is best illustrated in Figures 3 and 4, which show that Dahung only introduces the pilot fuel for discrete time periods, not continuously through operations.

Further, nowhere does Dahung suggest that injection of the main fuel and pilot fuel initiate concurrently. Dahung has an overall goal of creating a hybridized engine operation, where during certain operating regimes there is pre-mixed lean combustion and in others operating regimes diffusion combustion, which "is accomplished through varying the relationship of the pilot and gas fuel injection timings." Col. 2 lines 19-29; Col. 2 40-43. Figure 3 of Dahung demonstrates operation during high-load conditions, where a fully pre-mixed fuel/air mixture is first added to the combustion chamber, and at a later time, pilot fuel is injected to the reaction chamber to initiate burning. Shortly thereafter, pilot fuel injection is terminated to promote diffusion combustion mode. Col. 2 line 56 bridging Col. 3 line 3; Col. 6 lines 27-30.

Similarly, Figure 4 of Dahung shows low load conditions where a pilot fuel is injected prior to introducing the main fuel, but discontinuing the pilot fuel injection shortly after the main fuel introduction. At Col. 7 lines 24-27, Dahung states that "it is essential to inject the pilot fuel into the engine cylinder before the gas fuel as shown in Figure 4". Again, the pilot fuel is being used for a short period to "ignite" the main fuel, but there is no sustained injection of the pilot fuel. Col. 3 lines 11-16; Col. 7 lines 24-27. The Dahung offset timing of injection of respective pilot and main fuels is crucial to fulfill the Dahung operational objectives.

The Dahung operational objective are, however, entirely inapplicable to Appellants' claimed invention. Appellants' claimed invention relates to concurrently initiating injection of the fuel and the acetylene-based component. An HCCI engine operates by thorough pre-mixing of fuel(s) and air, hence why the injection of the fuel and acetylene-based component initiates concurrently and then mixing with air occurs.

The Dahung reference not only fails to provide a motivation to initially inject an acetylene-based component concurrently with a fuel into the engine, but explicitly teaches away from doing so.

Moreover, Dahung provides no guidance or suggestion to select an acetylene-based compound as recited in the claimed invention. There is no suggestion to select a specific acetylene-based component to improve operational efficiency of a self-ignitable fuel. Acetylene has entirely different properties from Dahung's suggested conventional pilot fuels, namely, methanol and standard diesel oil, including upper and lower flammability limits, auto-ignition temperatures, and minimum ignition energy, among others. One of skill in the art would not look to the limited class of pilot fuels used to ignite an otherwise non-ignitable fuel for improving performance in an HCCI engine, which uses a pre-mixed self-ignitable fuel. Thus, there is no suggestion or motivation in the Dahung reference to one of skill in the art to select an acetylene-based component for the combustion mixture to arrive at the presently claimed invention.

Further, pertaining to the specific rejections of Claims 17, 20, and 35 regarding the variation in load conditions, the Dahung reference does not specify varying the amount of pilot fuel through operation based on the engine's load, nor does it disclose keeping the amount of supplied pilot fuel constant. Dahung merely suggests that the timing of the injection of the pilot fuel should be varied based on load of the engine. It does not suggest modifying the quantity of pilot fuel to the engine.

As the primary reference, Dahung fails to suggest or provide motivation to one of skill in the art necessary to arrive at the invention in Claims 1-17 and 20-35. As previously pointed out, the additional cited references do not account for the

deficiencies of the rejections, because they do not provide the requisite motivation to modify and combine the Dahung reference, as will now be discussed in more detail with regard to the Examiner's use of each secondary reference.

US 4,419,969 to Bundrick

Bundrick fails to provide the suggestion or motivation necessary to modify the Dahung teachings to arrive at the claimed invention. Bundrick relates to an adjustable compression cylinder with flexibility to use "available" fuels in the engine for compression ignition. The non-limiting laundry list of "available fluid fuels" includes crude oil distillate, diesel oil, kerosene, gasoline, gasohol, and acetylene. Col. 2 lines 15-17. While this reference establishes that acetylene can be a compression ignition fuel in a spark engine (No. 48 of Figures 1-3), there is not a scintilla of suggestion or motivation that the listed fuels could or should be combined. Nor is there any guidance to select any particular combination of fuels from the recited list.

Rather, this reference suggests that an engine need not be dedicated to any particular fuel, so that it can use remaining/surplus stock fuels that are "available." One of skill in the art would not look to a reference listing "available" surplus fuels that can potentially be combusted in a flex-fuel engine to select a combination of fuel and additive for a sophisticated and highly calibrated HCCI engine. Thus, Bundrick does not disclose, suggest, or motivate one of skill in the art to concurrently initiate injection of an acetylene-based component with a fuel as a charge in an HCCI engine, and does not render the claimed invention obvious.

The Examiner argues that the Bundrick patent teaches use of acetylene in compression ignition, but, as discussed, the Bundrick patent teaches using an adjustable compression cylinder so adapt to available fuels; Bundrick does not suggest or provide any motivation for a combination of fuel and additive or, specifically, i) initiating concurrent injection of a fuel with an acetylene-based component to form a homogenous (pre-mixed) charge or ii) a continuous process where an acetylene-based component and a fuel are concurrently injected and mixed with air to form a combustion mixture.

US 4,765,293 to Gonzalez

The Gonzalez reference does not provide any suggestion or motivation necessary to modify the Dahung and Bundrick teachings arrive at the claimed invention. The Gonzalez reference provides a hybrid engine beginning with a stratified combustion cycle and gradually converting to a spark or glow plug assisted or non-assisted compression ignition diesel mode. Col. 1 lines 61-65. While no specific pilot fuels are mentioned, the Gonzalez engine operates by firing an igniter spark plug at the same time as the pilot injection to cause fire and hence fuel ignition. Col. 5 lines 39-43. Again, the pilot fuel is mixed and ignited prior to being introduced to a main fuel having lower ignitability.

The Examiner's statement that one would be led by Gonzalez to select either staged or concurrent pilot and main injections to "enhance the engine performance" is not borne out by what Gonzales teaches. Gonzalez states that the optimum timing of the pilot fuel injection is specific to any given application. However, the injection of the

pilot fuel injection and main fuel can be concurrent for low specific output or low compression engines. Col. 6 lines 1-3. Further, Gonzalez states that generally the main fuel injection will be timed after pilot injection. Col. 6 lines 3-5. The claimed HCCI engines are relatively high compression engines that achieve auto-ignition Thus, Gonzalez teaches away from using concurrent injection of pilot and main fuels for such a high compression application. One of skill in the art would not look to a spark-ignited pilot fuel injector for guidance on selecting fuel for operating an HCCI engine, which typically are high compression engines having issues with controlling combustion variability. The Gonzalez reference, then, combined with the Dahung and Bundrick teachings, still does not provide the motivation or suggestion necessary to render the rejected claims obvious.

A general statement that one would take measures to enhance engine performance does not supply the particularized motivation needed to establish prima facie obviousness.

US 4,765,293 to Dickey

The Dickey reference fails to suggest or motivate the skilled artisan to modify the Dahung, Bundrick, and Gonzalez teachings to arrive at the claimed invention. The Dickey reference provides an HCCI engine, where the charge/fuel is diesel fuel. This reference provides no motivation to include an acetylene-based component with a fuel in an HCCI engine. Further, it provides no suggestion to initiate injection of the acetylene-based component with a fuel concurrently. Hence, when combined with the

other references, Dickey still fails to provide the requisite motivation or suggestion to render the claims obvious.

US 4,765,293 to Britton

Similarly, no motivation can be found in the Britton reference which would render the rejected claims obvious. The Britton reference relates to a recuperator and, in passing, states that certain fuels, such as hydrogen and acetylene with lightweight molecules, have an increased flame speed and reduced ignition delay. In the context of Britton's teaching of a recuperator, this reference suggests that hydrogen and acetylene with lightweight molecules have an increased flame speed, but it is unclear how this could suggest to a skilled artisan that these compounds in particular should be used as an additive component for fuels in an HCCI engine. Thus, the Britton reference fails to account for the deficiencies of the other cited references.

US 5,409,784 to Bromberg, US 4,690,743 to Ethington and US 4,965,052 to Lowther

None of the Bromberg, Ethington, or Lowther references provide any suggestion or motivation to one of skill in the art that is required for the obviousness rejection. Each of these references relate to fuel-reformers that generate acetylene and/or hydrogen. None provides any motivation to modify the Dahung, Bundrick, and Gonzalez teachings to provide either i) initiating concurrent injection of a fuel with an acetylene-based component to form a homogenous (pre-mixed) charge or ii) a

continuous process where an acetylene-based component and a fuel are concurrently injected and mixed with air to form a combustion mixture.

Bromberg discloses a plasma generator that reforms fuel for a fuel cell. Many fuel cells employ hydrogen as fuel. While Bromberg states that a plasma reformer can generate acetylene and hydrogen, there still remains no suggestion to employ this combination of a fuel and an additive component in an HCCI engine system. As such, Bromberg does not render the claimed invention obvious.

Ethington does not suggest that a thermal reformer should be used to produce acetylene-based compounds for use in conjunction with an HCCI engine system. Nor does Lowther suggest that acetylene-based compounds can be reformed in an "engine reactor" and then used in an HCCI engine. Since none of the cited references, in combination or individually, provide suggestion or motivation to address the issues faced by the present inventors, the presently claimed invention is non-obvious and patentable.

Claims 10, 11, 26, and 34.

The limitations of Claims 10, 11, 26, and 34 have not been disclosed or even suggested by any of the cited art. These claims specifically recite ranges based on stoichiometry of the acetylene-based compound and its specific chemical properties, particularly in light of the behavior of the acetylene-based component in combination with the fuel selected for use within a specialized HCCI engine. A proper rejection must point to at least some reference having a mixture of acetylene-based component and fuel within the ranges set forth. There is no disclosure of the recited limitations of

Claims 10, 11, 26, and 34. These claims cannot be rendered obvious, because not one of the cited references meets the limitations set forth.

As maintained throughout the prosecution of the application, the Examiner has not supported the combinations set forth by identifying specific teachings, suggestions or motivations found in the references. The Examiner must shown reasons that the skilled artisan, confronted with the same problems as the inventor and with no knowledge of the claimed invention would select the elements from the cited prior art references for combination in the manner claimed. *In re Rouffett*, 47 USPQ2d 1453, 1458 (Fed. Cir. 1998). A failure to show the specific understanding or principle within the knowledge of a skilled artisan leads to an inference that the Examiner is utilizing hindsight construction. *Id.* Thus, there must be at least some motivation to combine the references, which is entirely lacking in the present case. As previously discussed, the standard of obviousness is not one of "obvious to try" generally in the art. *In re Fine*, 5 USPQ 1596 (Fed. Cir. 1998). As such, Applicants respectfully submit that the obviousness rejections of Claims 1-17 and 20-35 are improper and unsupported and request allowance thereof.

In view of the foregoing, the combinations of references are improper and otherwise fail to teach or suggest all of the elements of the claims as set forth.

Conclusion

While it has been necessary to examine each cited reference individually to demonstrate that none provides the requisite motivation to modify the primary Dahung reference in the ways necessary to arrive at Appellants' invention, such does not

"amount to a piecemeal dissection." Rather, when the teachings of all are taken into context and considered for what one or ordinary skill in the art would draw from them, it is seen that each fails to provide motivation to arrive at Appellants' invention.

The present claims are patentable over the cited art. Applicants, therefore, again respectfully petition this Honorable Board to reverse the final rejection of the claims on each ground and to indicate that all claims are allowable.

Respectfully submitted,

Dated: August 21, 2006

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